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Management of Diaphyseal Fractures of Humerus with Interlocking Nail – A Prospective Study in a Tertiary Care Hospital

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Abstract

Background: *Fractures of the humeral shaft are very common in upper limb fractures. It accounts for 3% of all fractures. Many treatment modalities are available for humeral shaft fractures. The present study tried to evaluate the outcome of the treatment of diaphyseal fractures of the humerus with interlocking nails.* ***Methods:*** *This cross-sectional study was conducted in the Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar. Patients included in the study were age more than 19 years the physis is fused. Closed reduction not feasible and patients with polytrauma where the closed reduction was not possible and patients with comminuted and pathological fractures. All the necessary blood investigations (complete blood count, blood urea, serum creatinine, blood sugar, HIV, HBsAg). ECGand chest X-rays were taken on a routine bases. All the cases were treated by closed intramedullary interlocking nailing in an antegrade manner except five cases which required the opening of fracture site to treat radial nerve palsy.* ***Results:*** *In our study, n=16(53.3%) patients had fractured at the middle third of the humerus, n=10(33.3%) patients had fractured at the lower third of humerus and n=4(13.3%) patients had fractured at the upper third of the humerus. In our study, n=10(33.3%) patients had oblique fracture, n=10(33.3%) patients had transverse fracture, another n=8(26.6%) patients had comminuted fracture and n=2(6.6%) patient had spiral fracture. Fixation of fracture n=25(83.4%) patients was treated by closed intramedullary nailing. These nails were passed in an antegrade manner and locked in static mode. N=5(16.6%) patients required open reduction because of associated radial nerve palsy, which was decompressed and the fracture was fixed with the interlocking nail in static mode.* ***Conclusion:*** *Closed intramedullary nailing with an interlocking nail is a safe and reliable method of treating humeral shaft fractures. It is an excellent method of managing comminuted and unstable humeral shaft fractures. Since closed nailing preserves the fracture hematoma, it appreciably decreases the time required for a fracture to consolidate and achieves a high rate of fracture union.*

Keywords*: Diaphyseal Fractures, Humerus, Interlocking Nail*

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Introduction

An increase in industrialization and technological improvements made an increase in the number of automobiles plying on roads and an increase in the number of high-speed thoroughfares has increased the incidence of trauma [1]. Fracture of the shaft of the humerus is no exception. The human body can heal fractures without outside assistance, but often leave a lot of deficiencies in terms of functional recovery because of shortening, mal-alignment, and joint stiffness. As time passed, the knowledge of fracture healing evolved, the need to intervene in fracture healing was felt. As newer and better procedures in the management of fractures are evolving, thus improving functional results. One can proudly say that the evolution and rapid development of orthopedic surgery has set a milestone in the treatment of

fractures. Conservative management, as a methodology of fracture treatment, was practiced by generations of eminent orthopedic surgeons. In fracture shaft of humerus, the conservative methods consisted of closed reduction and application of U- slab, Triple or Gutter splints and hanging arm cast [2]. But, the drawback of the above methods was that they involved immobilization of the shoulder and elbow for prolonged periods, thus resulting in stiffness and a drop in the functional outcome [3]. The two modalities of internal fixation in fracture shaft of the humerus are plate osteosynthesis and intramedullary nailing. Fixation with plates requires extensive dissection and is complicated by the proximity of the radial nerve and the risk of mechanical failure in osteopenic bones. Biomechanically, the intramedullary nail is a better implant. Nails are subjected to smaller bending loads and are less likely to fail due to fatigue. They act as load sharing and stress shielding devices. Cortical osteopenia that occurs right adjacent to the ends of plates is rarely seen in the case of internal fixation with intramedullary nails; thus, re-fracture after implant removal is seen less often [4]. Many studies have shown that union rates were much higher in cases of closed intramedullary nailing of fracture shaft humerus, as compared to where the fracture site was opened [5, 6]. Closed reduction and nailing preserve the fracture hematoma, which is essential for early fracture consolidation. Closed intramedullary nailing of fracture shaft of the humerus is the treatment of choice in polytrauma patients, fracture with overlying burns, patients with osteoporotic bone, pathological fractures and segmental fractures [7, 8]. The development of the interlocking nail system has dramatically broadened the indications of intramedullary nailing. Shaft fracture with severe comminution or bone loss, can now is treated with interlocking nails that control length and rotational alignment [9]. This treatment method has been the subject of controversy since its inception because of concern of damage to medullary circulation, possibilities of fat embolism, complications arising from the application of incorrect technique and a lack of understanding of the biomechanical principles of intramedullary interlocking nail fixation. So, we took up this study to evaluate the results of thirty cases, identify the advantages, difficulties, complications, pitfalls, and to prepare guidelines for the treatment of fracture shaft of the humerus.

Materials and Methods

This cross-sectional study was conducted in the Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar. Institutional Ethical committee permission was obtained for the study. Inclusion criteria were patients of both sexes belonging to the adult age group presenting with diaphyseal fracture of the humerus to the Orthopedics Department. Age more than 19 years the physis is fused. Closed reduction not feasible and patients with polytrauma where the closed reduction was not possible and patients with comminuted and pathological fractures. Exclusion criteria were those not fitting in inclusion criteria and all the open fractures of the humerus. A careful brief history was elicited from the patients and / or attendees to know the mechanism of injury and the severity of trauma. The patients were then assessed clinically to evaluate their general condition and local injury. The vital signs were recorded and associated with other systemic injuries that were carefully assessed. The local examination was carried out to detect the signs of fracture like swelling, deformity, tenderness, abnormal mobility, and crepitus. Any associated neurovascular deficit was noted. Radiographs of the affected arm including shoulder and elbow joints were taken in anteroposterior and lateral views. The limb was immobilized in a U-slab with collar and cuff sling for upper and middle third fractures. The posterior POP slab was given for lower third fractures. The operative procedure, its advantages, and likely complications were explained to the patient and informed consent was obtained. All the necessary blood investigations (complete blood count, blood urea, serum creatinine, blood sugar, HIV, HBsAg). ECGand chest X-rays were taken on a routine bases. Physician's fitness for surgery was obtained before the surgery. All the cases were treated by closed intramedullary interlocking nailing in an antegrade manner except five cases which required the opening of fracture site to treat radial nerve palsy.

Pre-operative preparation

The radiographs of the limb were carefully studied regarding the pattern of fracture and technical aspects of the surgery. With the help of radiographs, proper length and diameter of the nail required for surgery were selected and kept ready. A day before surgery all the instruments required for the procedure were checked and kept ready. The whole length of extremity was shaved, including the axilla. Patients were kept fasting for 8-10 hours prior to surgery. A written and informed consent for surgery was obtained. A pre-anesthetic checkup was done to all the patients. A systemic antibiotic and tetanus toxoid were given 1 hour before surgery. Nails used by us were AO type humerus interlocking nails. The nails are available in diameters of 6mm, 7mm, 8mm, 9mm, and 10mm. The 6mm and 7mm nails are solid while the 8mm, 9mm, and 10mm nails are cannulated, which can be inserted over a 2 mm guidewire. These nails are available in varying lengths from 200 mm to 300mm at an increment of 10mm. The locking screws are 2.9mm diameter for 6mm and 7mm nails and 3.9mm diameter for 8mm, 9mm, and 10mm nails. A standard surgical procedure was used for insertion of nails and postoperatively the arm is placed in a sling and early range of motion exercises for shoulder and elbow were started as soon as the pain subsides. Shoulder and elbow range of motion exercise is emphasized to avoid stiffness. In patients where there were no associated injuries or their presence did not warrant a hospital stay, after instructing regarding the range of motion exercises patients were discharged on 4th or 5th postoperative day and were asked to come for suture removal on 14th postoperative day. All the patients were followed up at monthly intervals for a period of 6 months or till the union of the fracture. Special stress is laid on the shoulder and elbow range of movements and subjective complaints. Radiographs were taken both in anteroposterior and lateral views to check for signs of the union.

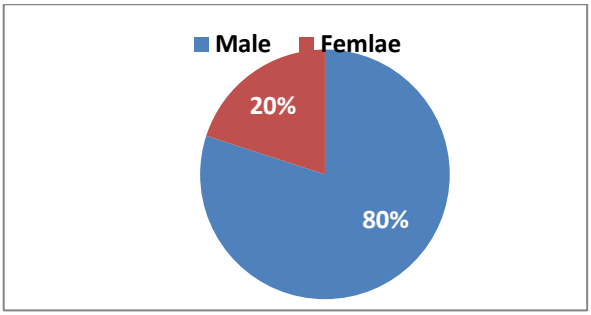
Results

Our study had n=30 cases of humeral shaft fractures treated by intramedullary nailing. Our patient's age range was from 21 years to 65 years with a mean age of 37.8 yrs. The majority of patients n=24 (80%) were males and only n=6(20%) were females. All the patients were followed for a minimum of 6 months.

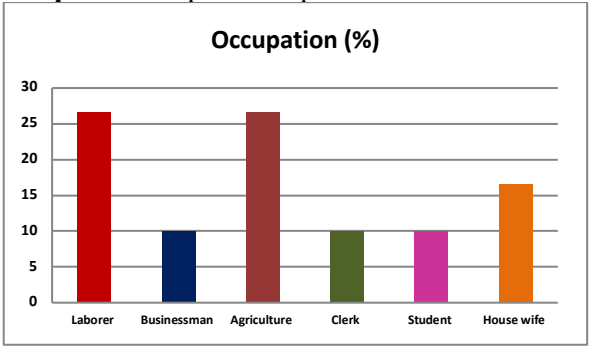
Table 1: Age-wise and distribution of patients in the study

Age Years	No. of Patients	Percentage
21 - 30	9	30
31 - 40	11	36.6
41 - 50	3	10
51 - 60	5	16.6
>61	2	6.6

Graph 1: Male and female percentage



Graph 2: Occupation of patients



Right side was involved in n=16(53.4%) patients and left side in n=14(46.6%) patients. Road traffic accidents were the commonest mode of injury accounting for 18(60%) patients, the remaining n=12(40%) patients were presented with the history of fall. In our study indirect injury was the commonest mechanism of injury accounting for n=20(66.6%) patients; the remaining n=10(33.3%) patients had the direct injury.

In our study, n=16(53.3%) patients had fractured at the middle third of the humerus, n=10(33.3%) patients had fractured at the lower third of humerus and n=4(13.3%) patients had fractured at the upper third of the humerus. In our study, n=10(33.3%) patients had oblique fracture, n=10(33.3%) patients had transverse

fracture, another n=8(26.6%) patients had comminuted fracture and n=2(6.6%) patient had spiral fracture.

Table 2: Side affected, mode of injury, mechanism of injury

Side	Number of Patients	Percentage
Right	16	53.4
Left	14	46.6
Mode of Injury		
RTA	18	60
FALL	12	40
Mechanism of Injury		
Direct	10	33.3
Indirect	20	66.6

Table 3: Site & pattern of fractures

Site of Fracture	Number of Patients	Percentage
U/3rd	4	13.3
M/3rd	16	53.3
L/3rd	10	33.3
Pattern of fracture		
Transverse	10	33.3
Oblique	10	33.3
Spiral	2	6.6
Comminuted	8	26.6

Associate injuries n=9(30%) patients had associated injuries, of which n=3(10%) patients had radial nerve palsy, n=1(3.3%) patient had rib fracture on the same side, n=1(3.3%) patient had fractured both bone forearm on the contralateral side, n=1(3.3%) patient had fracture shaft of tibia on the same side, n=1(3.3%) patient had mandible fracture, n=1(3.3%) patient had blunt abdominal injury and n=1(3.3%) patient had head injury.

Table 4: AO sub-classification of fractures

AO Type		Number of patients (n)	Percentage
A	A1	2	6.6
	A2	10	33.3
	A3	10	33.3
B	B1	0	0.0
	B2	4	13.3
	B3	3	10
C	C1	0	0.0
	C2	1	3.3
	C3	0	0.0

Most of the patients were operated within a week of trauma on an average, the time interval was 7.5 days. The delay in surgery was due to late in presentation and managing associated injuries. Fixation of fracturen=25(83.4%) patients was treated by closed intramedullary nailing. These nails were passed in an antegrade manner and locked in static mode. N=5(16.6%) patients required open reduction because of associated radial nerve palsy, which was decompressed and the fracture was fixed with an interlocking nail in static mode.

Table 5: Trauma to the surgery time interval

Trauma surgery interval	Number of Patients	Percentage
1-7 days	18	60
8-15 day	12	40

The Period of immobilization after surgery was noted it was found thatexcept for one case, which was immobilized externally with a pop slab for 3wks because of pain in the shoulder joint, all other cases were immobilized within 3 - 6 days postoperatively. The average had been 5.5 days.All the thirty cases were available for follow up. The average period of follow up was n=9 months. The period of fracture union ranged from 10 wks to 16 wks with an average period of 13wks, except one case which has gone for non-union.

Table 6: Time for Fracture union

Period of Union	Number of Patients	Percentage
10-12 weeks	11	36.6
13-16 weeks	18	60
Non-union	1	3.3

In our study of n=30 patients shoulder function was excellent in n=24(80%) patients, moderate in n=5(16.6%) patients and poor in n=1(3.3%) patient. Elbow function was excellent in n=27(90%) patients and moderate in n=3(10%) patients. The overall functional results were excellent in 80% patients, moderate in 16.6% patients and poor in 3.3% patients. In most of the pts, the functional outcome was satisfactory. Restriction of joint motion was seen in patients who were immobilized for a long duration.

Table 7: Functional assessments after treatment

Grade	Shoulder		Elbow		Total	
	N	%	N	%	N	%
Excellent	24	80	27	90	24	80
Moderate	5	16.6	3	10	5	16.6
Poor	1	3.3	0	0	1	3.3

Complications

Intraoperative complication

n=3(10%) patients suffered additional comminution at the fracture site while nailing insertion, but this did not affect the fracture union.

Postoperative complication

- ***Infection***
  In our study, there was n=1(3.3%) case of superficial infection which subsided with proper antibiotics. None of the patients had a deep infection.
- ***Impingement***
  n=3 (10%) patients had nail impingement of proximal end, as it was not buried completely into the bone. They had occasional pain in the shoulder with restriction of terminal 20 and 15 of abduction respectively. They had moderate functional outcomes
- ***Joint stiffness***
  n=1(3.3%) patient ended up with shoulder stiffness mainly abduction was affected and the range was up to 0-90. The patient was not following instructions of physiotherapy properly. The patient was complaining of severe
- ***Non-union***
  n=1(3.3%) patient was fixed in distraction at the fracture site. On follow up there were no signs of fracture union. The fracture ended in nonunion.

A secondary procedure with autologous bone graft was performed after 9 months, which achieved union later.

Discussion

Most of the acute humeral shaft fractures can be successfully treated by conservative methods. But operative stabilization is required in certain fractures, including those among patients with unsatisfactory closed reduction and multiple injuries. Plate osteosynthesis has yielded a high success rate but it needs extensive dissection with the risk of radial nerve damage and refracture after implant removal. Intramedullary nailing has the advantages of less soft tissue trauma and fewer chances of radial nerve injury, but the use of unlocked flexible nails has been complicated by poor rotational stability and slipping out of the nails causing joint irritation. Locked nailing overcomes these deficiencies and has produced satisfactory clinical results. In this study, we have treated 30 humeral shaft fractures with antegrade interlocking nailing. We evaluated our results and compared them with those obtained by various other studies opting different modalities of treatment for humeral shaft fractures. Fractures of the humeral shaft are commonly seen in middle-aged adults. In our study, we found patients age range from 21 years to 65 years with a mean age of 37.8 years and n=24 (80%) were males and only n=6(20%) were females M: F ratio was 4:1. Rommens et al; [10]treated n=39 patients with humeral shaft fractures with locked retrograde nailing. There were n=20 males and n=19 females with an average age being 43.8 years. Tingstand et al; [11]treated n=83 patients with plating. There were n=44 males and 38 females with a mean age of 32.8 years. The Mean age in our study was 37.8 years. Out of n=30 cases, n=24 were males and n=6 were females. In our study n=18(55%) patients, presented with a history of the road traffic accident. In studies by Crates et al; [12] Rommens et al; [10]series out of n=39 patients, n=21 gave the history of a road traffic accident. In a study by Bell MJ et al; [13]and Tingstad et al;[11] found that road traffic accident was the commonest mode of injury. In the present study, the middle third fractures were found in n=16(53.3%) was the commonest site the right extremity was commonly involved. In our study, n=22 out of n=30 cases (73.3%) fractures were of category A of the AO classification system. Jin L et al; [14] and Rommenes et al; [10] also found most of the humerus fractures were of category A. In our series n=29(96.6%) out of 30 fractures united with a mean time for union of 13 weeks (range 10 to 16 weeks). Vander Griend et al; [16] Bell et al; [13] Dabezies et al; [16]all reported union in 97%, Tingstad et al;[11] reported 94% union of humeral shaft fractures treated with AO plating techniques. As the flexible intramedullary nails lack rotational control, they are frequently associated with non-unions, Durbin et al; [16] reported a union in 92% of 30 humeral fractures treated with Hackethal nailing. Brumback et al; [17] obtained union in 94% of 58 fractures treated with Rush and Ender's nails. More rigid locked intramedullary nails have better rotational control than flexible nails,

which theoretically should decrease the frequency of nonunion. Riemer et al; [18]reported no nonunions in 28 acute humeral shaft fractures treated with seidel nails**.** Rommens et al; [10] reported union in 95% of fractures with a mean time for union of 13.7 weeks. Jensen et al; [19] reported a 92% fracture union after seidel nailing in 16 patients. Jinn Lin et al; [14] reported 100% union with a mean time to union of 8.6 weeks. Crates et al; [12] reported 97% union of fractures treated with antegrade Russell-Taylor nailing, with a mean time of 3.2 months. There was no transient iatrogenic radial nerve palsy in the present study. Postoperative early mobilization of the shoulder and elbow was very critical in attaining a full range of movements. It was observed that the movements and the functional ability of the shoulder depending upon the patient's adherence to a rehabilitation program and early intensive physiotherapy hastened the recovery of shoulder function. But as the study sample was very small, for the better conclusion it has to be repeated in a larger group of patients with longer follow up periods.

Conclusion

The results of the present study show that all closed and Grade I open humeral shaft fractures extending between 2 cm from surgical neck to 3cm proximal to the olecranon fossa can be stabilized with closed intramedullary nailing. Closed intramedullary nailing with an interlocking nail is a safe and reliable method of treating humeral shaft fractures. It is an excellent method of managing comminuted and unstable humeral shaft fractures. Since closed nailing preserves the fracture hematoma, it appreciably decreases the time required for a fracture to consolidate and achieves a high rate of fracture union. Early and intensive physiotherapy hastens the recovery of shoulder functions.

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